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August 13, 1948

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(See page 152)

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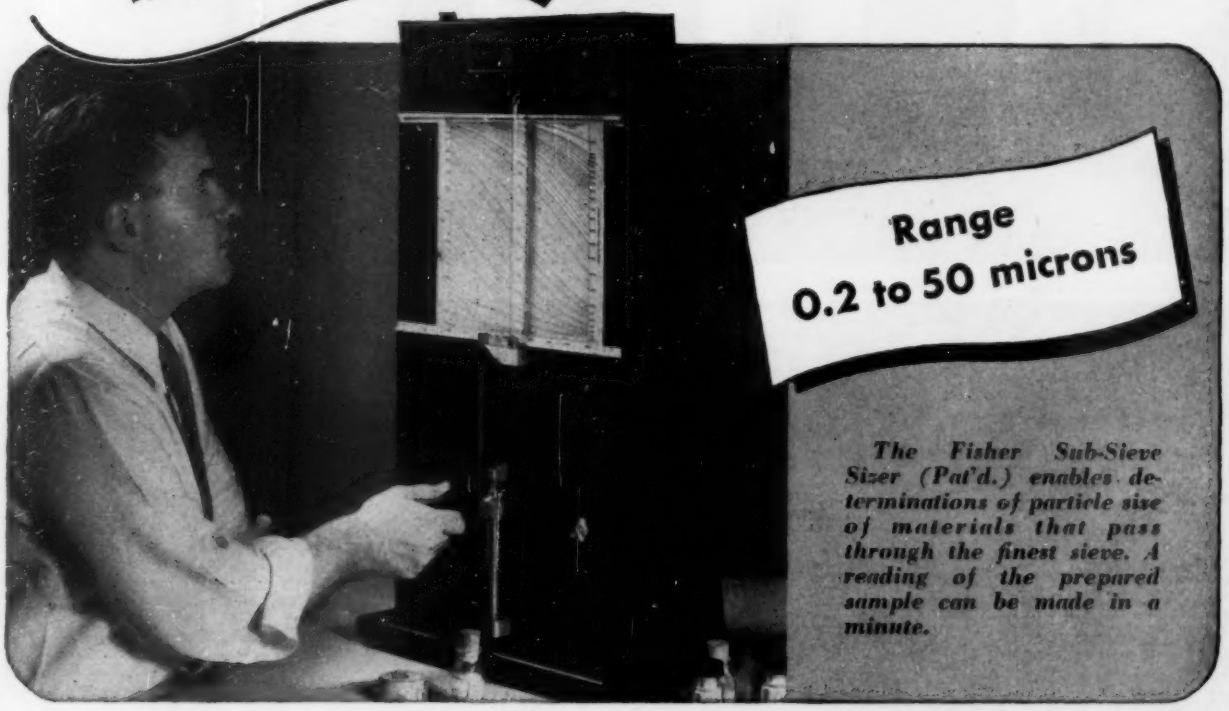
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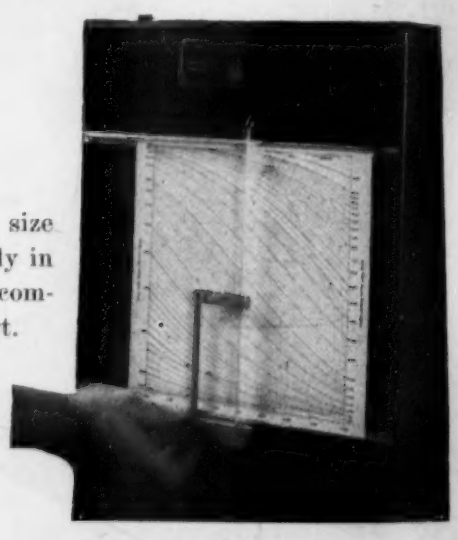

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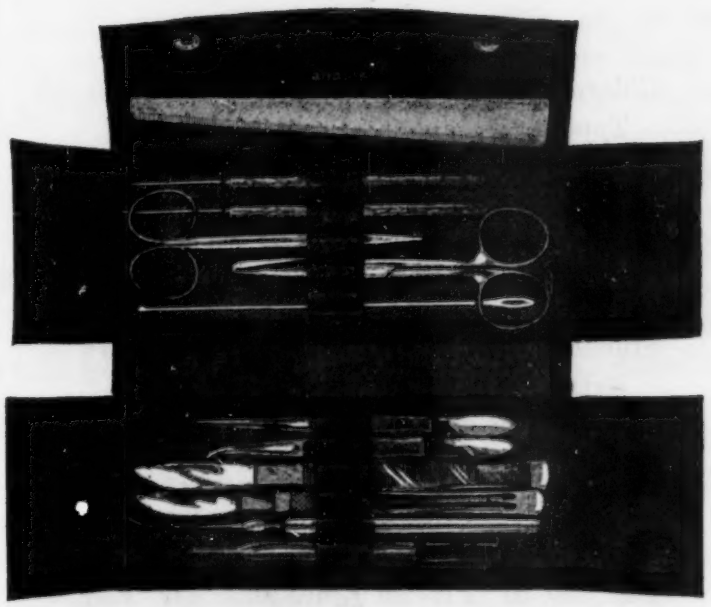

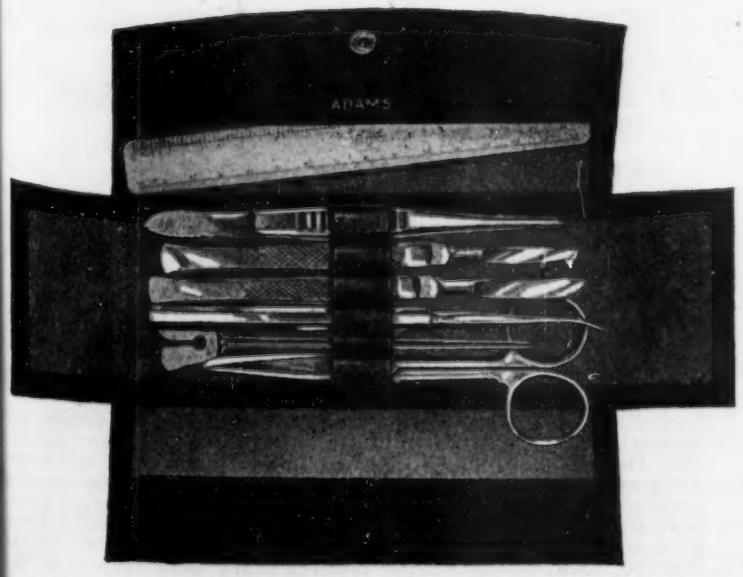

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Science in the Universities

William H. Taliaferro

Department of Bacteriology and Parasitology, University of Chicago

SCIENCE CONCERNS US ALL, and especially those who have just completed their university training. These young men and women are going to live and win their spurs in a world which is increasingly influenced by science. Many are preparing to make their living in scientific research or teaching, or in professions, like medicine, which apply science. Even if their careers are in fields remote from science, their future well-being cannot fail to be profoundly influenced by present and forthcoming developments in scientific research. Above all, the last decade has demonstrated that this country needs a strong science if it is to be the type of postwar country we desire or probably even if it is going to survive.

There is but one science, but for convenience we contrast that type which we term fundamental, basic, or pure, with that type which we term applied or developmental. At the extremes, this division is sharp. It is easy to distinguish the purely basic work of the nuclear physicist, who is interested in understanding the structure of the atom, from the applied work of the scientist and engineer, who are interested in manufacturing the atomic bomb; it is easy to recognize the basic character of the work of the biologist, who is studying the hormonal regulation of physiological processes, and the applied work of the clinician, who is using hormones in curative medicine. Actually, however, there is a gradual spectrum of interest starting with fundamental science, whose votaries try to understand and explain natural phenomena without regard to practical value, and extending to developmental science, whose adherents attempt to apply basic science to the needs of mankind. Frequently, both types of work are done by the same person. I wish to discuss basic science and some of the dangers it is facing.

It is hardly necessary to mention that science is more than exact observation, accurate measurement, and detailed analysis; nor is it necessary to point out the freedoms necessary for the preservation of basic research and teaching in the universities. No discussion of basic science would be complete, however, without mentioning the value of pathfinders, "worthless facts," and luck. Like other people, most scientists follow pathfinders—those men who become leaders because they have the flair for tying scientific observations to some exciting or ingenious hypothesis, which stimulates others to test the hypothesis and thereby accumulate more observations. It is not unexpected, therefore, that many observations, unnoticed, ignored, or forgotten because they do not seem important at the time, bob up to form integral parts of the basis of scientific laws formulated later. Luck always plays an important role, but it generally happens to what has been termed the prepared mind. Thus, it was intelligence that led Morgan and his co-workers to turn to the fruit fly, which Lutz had shown was peculiarly well adapted for genetic studies because of its ease of handling and short life-cycle. It was sheer luck that the fly was later found to show "crossing over" of characters in the female and not in the male—a combination which was exploited to the utmost in the brilliant studies of linkage and in determining the loci of genes in the chromosomes.

We need both pure and applied science in our universities. No one wishes to belittle or stop the great applications of science in medicine, in agriculture, in engineering, in industry, or even in war, when our country is in danger. Not only must men be interested in such work in our universities, but, actually, when they are working shoulder to shoulder with basic scientists, there is mutual stimulation and benefit. We need have no fear, however, about the continuation of high-grade applied science in the universities. Everything, today, is making it easier and easier for universities to develop this type of science. The sales appeal is self-evident for the support of work which promises to yield a better artificial rubber, a method of keeping fats from becoming rancid, or a cure for some dread disease. But there is no appeal except the ardent interest of some scientist for the support of work which deals with the symbiotic relationship of termites and their intestinal protozoa, the reactions of a flat worm to light, the oxidation of pyruvic acid in minced pigeon breast muscle—to mention an infinitesimal few.

It may seem strange, on this day, to talk on the thesis that science in our universities is in danger, especially when unheard-of millions of dollars are being poured into it by the Government, industry, and private philanthropy, when our scientific departments are crowded with students, and when the American public is more science conscious than ever before in our history. It is basic science that is in danger, however, not applied science.

Address delivered at the 231st Convocation, University of Chicago, December 19, 1947.

The fact that basic science is in danger is of consequence to all of us, because universities and nonprofit research organizations, by their very nature, are its chief shepherds and custodians. In fact, in spite of many points in common, basic science and applied science thrive best under different conditions. Developmental or applied science can, to a large extent, be satisfactorily carried out and greatly accelerated by the organization of large teams of scientists and technicians under scientific directors. No clearer example of this is seen than the remarkable work done by the Office of Scientific Research and Development during the war. Just as surely as directed and organized research yields results in developmental work, it fails to yield equal results in basic fundamental research. This stems from the fact that the director and his staff know their ultimate goal in applied work and can make fairly good guesses as to what basic findings already known can be best applied. The basic scientist, to a greater extent, defines his goal in terms of interest and is largely dependent on lucky guesses (inspiration, if you like) and often just plain fumbling. For this reason, the basic scientist is much more of a lone-wolf than the applied variety. His work cannot be directed, because he must be allowed to change his goal as he works and because his best ideas are unorthodox and are only too often known to be impractical by his famous colleagues who would be his most likely directors. It is the abstract, atypically brilliant individual, considered peculiar by the practical man, who most often provides the keystone to the arch of accumulated scientific evidence that makes possible the formulation of broad, often sweeping generalizations. An example of this is Einstein's formulation of the relationship of matter and energy in the deceptively simple equation, $E = mc^2$, which played such a great part in the study of the fission of the atom. Another example is the study of the food requirements of bacteria which led to the first rational theory of the action of chemotherapeutic drugs.

Several things are conspiring to jeopardize basic science in our universities. We lost ground because of the necessity of diverting the interest of our basic scientists to developmental work during the war. We lost a large part of one generation of young scientists through a not-too-enlightened policy of training during the war. Now we are rapidly losing many of our best basic scientists, especially the younger ones, because they are being enticed into industrial and government laboratories by high salaries and by equipment which is beyond the means of the universities. Although some will continue to do basic work in their new positions, all will be influenced to some degree by immediate or practical objectives, and most will become more and more interested in developmental aspects of science and will be completely removed from teaching.

Even the interests of our basic scientists who remain at the universities are being endangered by the large sums which are being poured into science. Lest I be misunderstood, let me say at once that I should be the last to question such generosity, especially during these times of increasing prices and decreasing income. Let us, however, face the dangers frankly. Most grants from commercial companies and frequently those from the Government are for applied fields. Some of these are absolutely necessary for applied fields which are legitimate for universities. These and others support a certain fraction of basic work. The question is: How far can the basic scientist accept such grants without losing his fundamental attitude? Will he recognize the insidious danger in time? Will he change his problem or interest to fit the terms of a proposed grant for applied work?

It is generally agreed today that, with the rapid disappearance of large fortunes and the continuing diminishing income from endowments, all of our universities and, in particular, our privately endowed universities must turn to the Government for support of their scientific research. In not a few cases, government officials have given grants for basic work with a minimum of direction and interference. Such grants are admirable, and the responsible officials are to be congratulated to the fullest. Inevitably, however, officials will be under continuous and, I expect, increasing pressure to pick fields and approve projects which are directly concerned with, or which they believe will help, applied subjects of special importance to their agencies. The officials will also be faced with the danger of orthodoxy. They will have to rely on boards of experts frequently composed of famous university scientists for the selection of projects. Such boards are generally conventional in their collective views and, hence, tend to frown on seemingly impractical ideas. This tendency will limit the number of really new types of research which are inestimably the most valuable.

The value of unorthodoxy and the disregard or ignorance of current scientific dogma is well illustrated by the remark of a former colleague that he liked to have young men in his department because they had such fool ideas. Most of these fool ideas, he went on to explain, were no good, but when one of them panned out, it was something that no well-trained man would ever have thought of.

We must find a way to support men and not projects. We must support the promising young men and the able mature scientists without regard to what they are doing. Some such method is necessary not only to let the scientist follow new leads as they ap-

pear, but also to keep the universities from financial ruin. The common practice at present, to pay only the direct costs of a project, is an increasing drain on our university finances because of the many hidden costs of research.

This problem has been recognized by some of the proponents of the National Science Foundation. Among other types of support, large unrestricted grants to the universities have been proposed for scientific work. None, however, has so far been made. If made, such grants would represent a wise evolution of government policy in supporting science.

While some departments of the Government and a few industries are alarmed at the situation, as indicated by the government grants just mentioned and a few similar ones from industry, all agencies should try harder to do something about it, if for no other reason than selfish interest. All must learn that they should support unrestricted, undirected basic science. It is probably too much to hope for, but if they were truly wise, they would support universities without regard to subject, because no science—and least of all basic science—can exist in a vacuum. In the first place, if the present trend continues, the Government and industry will not be able to obtain a supply of properly trained men, even for applied work. In the second place, really new technological developments stem largely from findings regarding the fundamental workings of nature which are not suspected to have practical value at the time of their discovery. No man can guess what knowledge will be practically applied next. How many men, for example, would have suspected that the discovery by Alexander Fleming of the fact that the mold, *Penicillium,* is antagonistic to certain bacteria would lead to the practical drug which we now know as penicillin? Who could have predicted that Clerk Maxwell's work in 1865 and 1873 on the propagation of electric action through space and the experimental and mathematical work of Heinrich Hertz in 1888 and 1889 on the electromagnetic effects of rapid electric oscillations would eventually lead to modern radio? If we are going to have a backlog of fundamental findings sufficient to support various medical, agricultural, and technological developments, we must find a way to support countless investigations on the workings of nature that at the time seem to have no possibility of practical value. To put it another way, if we support only work which the wisest men believe promises practical application, we shall miss, almost by definition, new and revolutionary discoveries. From the very nature of things, most of this basic work will have to be done in universities and other nonprofit organizations.

One can say with a great deal of truth that the situation I have described results from the fact that our universities and nonprofit research organizations are plagued by decreasing incomes and increasing costs. In part, however, they are plagued by a lack of understanding of the nature of basic science and by confusing it with applied science. Ask the average government or business executive, not to say many university administrators, what country has led in basic science, and he will generally answer: "The United States." Nothing could be farther from the truth. Having been a pioneer country until only recently, the United States has emphasized the practical and applied aspects of science and, with certain very notable exceptions, has relied upon Europe for discoveries in basic science. In thus not differentiating between the two varieties of science, applied work is naturally lauded because it promises greater immediate returns. The shortsightedness of this attitude lies in the fact, as mentioned before, that basic science is the spring—the source—of applied science. Fortunately, throughout its history, the United States has produced a few outstanding basic scientists, and, in recent years, this few has grown to amazing proportions. We have thus proved that we can lead. If we are going to continue to lead, we must divert resources to fundamental science to a much greater extent than we have in the past or are doing now.

Our government officials and especially our business executives can learn a great deal from our great medical leaders. Medicine is, and should be, first of all a profession dedicated to the application of science to the prevention and alleviation of human disease. A large proportion of its rank and file understandably looks down on any basic science that cannot be justified by practical application to medicine and public health. Its top leaders, however, recognize that the profession cannot really advance without a firm foundation in basic science. They not only insist on basic science as a preparation for medicine, but approve its forming a large part of the professional curriculum leading to the M.D. degree. They support basic science only tenuously connected with medicine. They recognize the fact that the really new clinical applications are just as likely to come from basic science entirely unrelated to medicine as from medicine itself. This is illustrated by the development of such new antibiotics as streptomycin from what would originally have been termed agricultural bacteriology. Finally, some of our great basic biologists are recruited from routinely trained medical men.

Here at the University of Chicago basic biology and the Medical School have been combined into the Division of Biological Sciences. I have always believed, and we are fast demonstrating, that this combination gives the greatest opportunity to build mutual respect between the basic biologist and clinician, to infiltrate

medicine with basic science, and to reap the benefits of the mutual stimulation of basic and applied science.

The dangers I have referred to are real and concern all those interested in universities. The damage probably will not go as far as feared by one of my colleagues, who remarked that, if the present trend keeps up, our scientific faculties will eventually consist of the overaged, the incompetent, and a few fanatics who prefer the academic atmosphere, no matter what the cost. Yet it is true that basic science has always had to depend a great deal on fanatics or "queer ducks," and I am sure it will continue to do so. To those who belong to this peculiar group and who are willing to continue in university work, there are compensations for the flesh pots of his life payable in the joy of teaching, in the advantage of close contact with scholars in other disciplines, and in real freedom and independence in intellectual pursuits. These benefits of academic life mitigate the lack of great material rewards. They are sufficiently satisfying, provided the disparity in the material reward of the basic and applied scientist is not too great. It is up to the various interested parties to see that the present unjust difference is lessened in order that one of the important reasons for the present grave situation may be corrected. The difference should, however, not be entirely eliminated, because too great an emphasis on material rewards would result in recruiting to the universities men who are lacking the missionary spirit and the burning interest in understanding nature that are so necessary for basic research.

Royal Society Scientific Information Conference

Ralph R. Shaw, *Librarian*[1]
U. S. Department of Agriculture

WHILE THE WAR WAS STILL IN ITS DARK PHASE, in 1941, Dr. Alexander King, then of the Ministry of Supply and now of the Central Scientific Secretariat, and Mr. Neville Wright, then of the New Zealand Office in London, approached the secretaries of the Royal Society to propose an Empire Scientific Conference. After three years of study it was decided that an Empire Scientific Conference should be convened as soon as possible after the war. The Conference was finally set for 1946 and was planned in two parts: a Royal Society Empire Scientific Conference, followed by a British Commonwealth Official Scientific Conference.

During the course of these conferences it became evident that scientific information services are a matter of first importance to the development of science, and it was therefore recommended by the Empire Scientific Conference that the Royal Society convene a conference of libraries, societies, and institutions responsible for publishing, abstracting, and information services in order to examine the possibility of improvement in existing methods of collection, indexing, and distribution of scientific literature. The British Commonwealth Official Scientific Conference endorsed this proposal and adopted the following resolution:

> The Conference endorses the general recommendation of the Royal Society's Conference but desires to record its opinion that such a discussion should be regarded as preliminary to a wider Conference, invitations to which should be extended to the U.S.A. as well as to the operating agencies of the United Nations which are concerned with the subject.

The Royal Society, in accepting responsibility for arrangement of the Scientific Information Conference, provided that it ". . . will be limited by considering the subject only from the point of view of use and service to the scientific community. . . ." This Conference was held in London from June 21 to July 2, 1948.

Planning the Conference

Preparatory work divided subjects before the Conference into four sections: (1) publication and distribution of papers reporting original work, (2) abstracting services, (3) indexing and other library services, and (4) reviews and annual reports.

Planning of the meeting, extending over more than 6 months, resulted in the preparation of 46 papers dealing with various aspects of the work of the Conference and in the statement of more than 100 problems relating to scientific communication, for consideration by the Conference.

While substantially all of the subjects considered have been discussed over the years by scholars and by librarians, the distinguishing features of this Conference were: (1) that, as noted above, subjects were to be considered only from the point of view of use and service to science; (2) that the scientific

[1] Representative of the U. S. Government at the Conference on behalf of the Department of State and its London Scientific Mission.

method was evidenced in preparations for the Conference, notably in the gathering of facts upon which sound decisions might be based; and (3) that the Conference, as stated by Sir Henry Tizard, considered particularly the problems of scientists in isolated places, who do not have immediate access to extensive library facilities.

Major Topics Covered

Many of the topics for discussion which were formulated by the preparatory meetings appeared to the working committees to require additional experimentation before sound decisions could be reached; a few others were judged matters of technique which did not appear to have vital significance for scientific communication and were dropped without recommendation; still others seemed to defy solution on an Empire-wide base because of varying conditions under which they must be applied. The major issues discussed by each of the four sections of the Conference are noted below.

I. *Publication and Distribution of Papers Reporting Original Research*

The major issue in the field of preparation and presentation of scientific literature was the proposal put forth by J. D. Bernal, over the last few years, that all scientific communications be issued as separates rather than as periodical articles. This plan, which is described in Conference Paper No. 2, provides also for central distribution of manuscripts to editorial boards of the scientific societies and for central publication and distribution of these separates. This proposal met with violent opposition and was the subject of considerable newspaper publicity before the Conference started. It was withdrawn from consideration by its author.

A second proposal concerned improvement in preparation of scientific literature. The group attempted to determine what measures might be taken to improve the quality of manuscripts. Here considerable emphasis was placed on the need for judging publications solely on their scientific merits and on continuing effort to save time at all stages from the completion of actual research to final publication.

Précis journals were proposed both as a means for covering large areas of literature which are not now covered by abstract journals and as a means for saving time for scientists, who might, by reading a précis journal, keep up with general developments in their own and related fields without handling a large number of separate publications. During extensive discussion of this subject it was pointed out that, although précis journals might be desirable in some fields, in fields such as chemistry a journal providing a one- or two-page précis of each article would run to thousands of pages every month and would largely duplicate abstracting journals. The final recommendation, therefore, was that the Royal Society should consult editors and controlling bodies of groups of journals to find out whether précis journals might be of value in certain fields and whether facilities for their production can be made available.

Auxiliary publication was a fourth major topic. This term refers to a technique developed by the American Documentation Institute for making available papers which are too long or too complicated for economical publication, or which are of interest to a number of scientists which is too small to justify publication. This scheme provides for publishing an abstract or an abbreviated paper in a suitable journal, indicating that a microfilm or photostat copy of the whole article may be obtained. The chief problem which arose in this respect was taxonomic, since international rules for nomenclature do not now provide for recognition of auxiliary publication as true publication in the determination of priority of descriptions of plants or animals.

A fifth recommendation of importance dealt with payment by authors for part or all of the cost of publishing their articles. At first there was a tendency to state that it is undesirable that authors be asked to pay for the cost of their publications in any circumstances. It was finally decided that no recommendation for action would be made, but that the sense of the Conference—that payment by authors is generally undesirable—be included in the report as a conclusion.

Provision of reprints received a great deal of attention, both because of its relationship to Prof. Bernal's proposal, noted above, and because of the extent to which scientists are thought to use separates in their personal collections.

Paper No. 46 indicates that the use of reprints by scientists constitutes a much smaller proportion of their use of literature than had previously been estimated. Nevertheless, according to this preliminary study, about 5 or 6% of the literature used by scientists may be in the form of reprints. The recommendation on the provision of reprints recognizes that there is additional value in the personal contacts which result from individual exchanges of reprints and suggests continuance of the present procedure. It further recommends study to determine whether central facilities for securing reprints can be developed in order to make them more readily available.

Since preliminary investigation (see Paper No. 46) showed that approximately 80% of all scientific literature is obtained from libraries, as against some 20% from all other sources combined, the Conference

recommended that enlargement and increased support of central scientific libraries is absolutely essential.

II. *Abstracting Services*

Based on the finding that few scientists really do have facility in foreign languages, it was recommended that more detailed abstracts be given of articles published in foreign languages and for those in publications not readily available, that comprehensive subject indexes be provided in each volume of abstracts, and that consolidated subject indexes be issued at least every 10 years. The relationship of indexing to abstracting was also recognized, and it was recommended that prompt announcement of authors and titles of papers (with annotations if possible) would be very desirable in all fields and that a continuing consultative committee of abstract organizations be established for exchange of views and for the promotion of cooperation generally.

Author summaries evoked a considerable amount of discussion, and it was finally concluded that, while the present general unsuitability of author summaries for use as abstracts is recognized, nevertheless, if these could be used, the speed of publication would be increased and the cost of abstract journals reduced. It was therefore recommended that the Royal Society invite editors of scientific journals to cooperate with abstracting organizations by seeing that each paper is accompanied by a factual summary suitable for use as an abstract and that abstracting organizations be called upon to formulate agreed principles to guide editors of scientific journals.

III. *Indexing and Library Services*

This section was assigned more problems of detail than were found in the other sections, and, in view of the fact that it dealt with administrative problems to a greater degree than others, it was difficult to arrive at general recommendations on processes and procedures. For example, in recommending one process as against another, the relations of labor and material costs vary very widely between countries. Clerical staff may, in fact, cost 40 times as much in one of the countries represented as it does in another. Thus, many of the recommendations in this section were fairly general, and here, as in other sections, one of the most valuable parts of the Conference was the number of fields in which the need for additional objective investigation was pointed up. This group discussed Universal Decimal Classification, alphabetic indexing, issuance of catalog cards with publications, the relative merits of the various photographic processes and means of mechanical selection, proposed changes in organic chemical notations and systems of organic chemical notations, training and status of special librarians and information officers, specific additional reference works needed, translation services, and the provision of copies of scientific literature to scientists at a distance from research libraries.

The recommendations were, for the reasons noted above, quite general and indicated need for further investigation under the conditions under which the techniques were to be applied. Only in the field of copying services were there implications which were basic to the primary purposes of the Conference. The confusion in legal interpretation of the right of scientists to copy and quote and the resultant confusion in the right of scientists to have material copied for them were determined to be a major block to scientific communication. The Conference adopted the following recommendation with respect to copyright:

> Copyright.—This Conference recommends that the Royal Society adopt the following position in relation to copying, and that it exert its influence to obtain universal acceptance of this principle:
>
> As science rests upon its published record, ready access to public scientific and technical information is a fundamental need of scientists everywhere. All bars to access to scientific and technical publications should be removed.
>
> The Conference believes that making single copies of extracts from books or periodicals is a fundamental need of research workers, and that the production of such single extract copies by any means, by or on behalf of scientists, is necessary for scientific practice.
>
> In some countries it appears that copyright restrictions are preventing the quick and free flow of scientific information to research workers and some action is necessary to overcome this. It is recommended that the Royal Society should initiate such action.

IV. *Reviews, Annual Reports*

The chief recommendations of the group working on reviews and annual reports, as passed by the final plenary session, were: (1) that critical and constructive reviews written by leading specialists in particular fields are of the greatest value. These reviews should be made informative to nonspecialists by general introduction and conclusion. Senior investigators should regard the production of these as of comparable importance to the pursuit of new knowledge; (2) that the attention of the relevant societies and institutions, as well as government organizations, should be drawn to the importance of providing reviews in the progress of the applied sciences.

The Conference closed with the general recommendation that it ask the Royal Society to investigate the possibility of the continuation of research into the uses of scientific literature and other topics referred for further consideration by the Conference and that a continuing committee be established for this purpose.

It was further recommended that the Royal Society seek funds to carry out this recommendation. Finally, the Conference authorized the redrafting of these resolutions.

Summary and Evaluation

Since the recommendations have not yet been put into final form and the Council of the Royal Society has not yet acted on them, it is a little early to say what the final results of the Conference will be. However, it would appear that these will have to be measured over the years rather than by achievement during the next few months.

Summarizing the purpose and operation of the Conference, it might be stated that the central theme of the Conference appeared to be removal of blocks, whatever their nature, which interfere with free communication among scientists, wherever they may be located and whatever their fields of specialization.

If it is agreed that the advancement of science rests primarily upon the genius of each scientist in his laboratory, whether that laboratory be in a great center of research or in an isolated corner of the world, and that each scientist, no matter where he may be, must profit from the work of his colleagues, all over the world and of all times, then it must follow that anything which contributes to the freedom and ease of communication among scientists is, per se, a contribution to science.

It is in that light that the Scientific Information Conference justified the time and energy of a group of the caliber which it assembled and the sponsorship under which it was brought together. The extent to which it may contribute to the advancement of science by improving communication among scientists is the yardstick by which the success of the Conference should, in the final analysis, be measured.

Viewed in this frame of reference, the Conference appeared to attack the problems of limitations upon freedom of communication among scientists along three major fronts:

First, there is the broad area of possible improvement in communication through publishing. In the light of the purposes of this Conference, publishing may be viewed as a mechanism through which any scientists may speak to all scientists, all over the world and for all time. Conversely, it is the mechanism through which each individual scientist may receive the recorded findings and thoughts of his colleagues, of all times and places, in a form in which he can give them the attention which they may warrant.

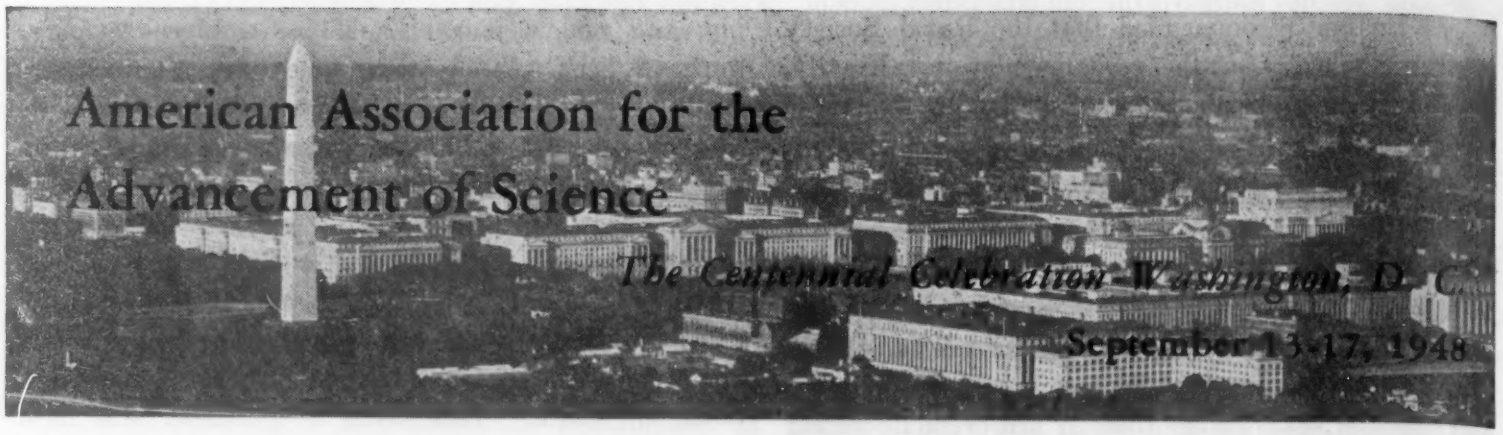
The second broad front on which this Conference appears to have worked is the intellectual Tower of Babel resulting from the great mass of scientific literature assembled over the ages in our libraries, documentation centers, and in our indexing, abstracting, and review journals. Major emphasis appears to have been placed upon secondary publications, such as listing, abstracting, and review series, and on library and other techniques for organization of literature, in a search for measures which may tend toward the clarification of the deafening confusion of tongues.

The third and final goal of the Conference appears to have stemmed from the concept of the advancement of science noted above and therefore revolves about the needs of the individual scientist—any scientists, anywhere. This issue is probably the most crucial one involved in the Conference, and it is one which has no other organized sponsorship. Publishing will evolve and improve, as it has over the ages, through the interested efforts of private publishers and of various scientific bodies. Libraries and documentation services will no doubt continue to grow and improve. However, the needs of the scientist who is working at some distance from a good library and who cannot, obviously, acquire everything published—or even learn about all that has been published—cannot be served even partially unless new philosophies and new services are developed.

It is not feasible to duplicate the world's great research libraries at all points at which research must be carried on. If we do not believe that science evolves upon its written record, then we are wasting time and money in building up great libraries anywhere. If, as has adequately been demonstrated, good library facilities are indispensable to the advancement of science, then we must expect inferior science from those who cannot work at the great research centers until mechanisms are developed to insure that every scientist, no matter where he may be, may have access to the recorded record of science to the full extent to which it can contribute to his investigations. Any advances made or suggested in this area by the quality of pooled scientific judgment represented by this Conference should be watched as possible major contributions to the advancement of science.

Regardless of future benefits which will undoubtedly accrue to science from this Conference, its objective approach and its high level of consideration of the tools of scientific communication in terms of contribution to science may well be a landmark in scientific communication. The approach to problems of scientific communication on the basis of objective data, if it leads to a continuing tendency to make decisions in this field on the basis of the scientific method instead of the basis of habit or personal predilection, will be a second major contribution.

The final recommendations and proceedings of the Conference will be available for distribution in a few months. When issued, they will merit serious study by all who are interested in the advancement of science.



The National Bureau of Standards

The National Bureau of Standards, established in 1901, is the principal agency of the Federal Government for fundamental research in physics, mathematics, chemistry, and engineering. With a staff of 2,800 (including 1,200 scientists and engineers), grounds totaling 68 acres, and 95 buildings (20 major, 75 minor), it consists of 13 scientific and technical divisions, 1 concerned with commodity standards, and 4 concerned with administrative and plant matters.

The activities of the Bureau, coinciding with the range of the physical sciences, are diversified and extensive. Three broad categories summarize the type of work done: research and development; test, calibration, and standard samples; and advisory services. In general, each of the divisions and sections of the Bureau is engaged in all of these phases.

The administrative staff consists of the director, E. U. Condon, and his office: E. C. Crittenden and W. R. Brode (associate directors), D. I. Vinogradoff and Hugh Odishaw (assistants to the director), and T. B. Morrow (executive officer). A few of the projects of the Bureau, listed under divisional headings, will indicate the nature and scope of the work.

Electronics (Harry Diamond, chief): The chief programs involve (1) electron tube research, development, and standardization; (2) physical electronics research; (3) electronic instrumentation; (4) electronic circuits and controls; and (5) electronic computers. Investigations are under way on thermionic and secondary emission, electron microscopy, ultrasmall electronic circuits, high-frequency micrometers, input and output transcribers for digital computing machines, cathode metal impurities, and printed circuits.

Applied Mathematics (J. H. Curtiss, chief): A centralized program in mathematics and electronic computing machines is in progress with the cooperation of the Office of Naval Research and other government agencies. Highly specialized mathematical tables, such as spherical scattering functions for complex arguments, spherical Bessel functions, confluent hypergeometric functions, and tables of intensity functions for complex indices of refraction, are prepared. Considerable work in applying modern statistical inference to complex engineering experiments and sampling problems is performed.

Radio Propagation (Newbern Smith, acting chief): Basic Radio Propagation Predictions are issued monthly. Research projects include basic microwave, frequency utilization, and ionosphere research, behavior of high-frequency direction finders, cosmic and atmospheric noise, sunspot predictions, and fundamental work in standards and measurements.

Mechanics and Sound (W. Ramberg, chief): Projects include thermal-noise thermometers, measurement of hearing-aid gain, oscillation of quartz plates, sound insulation in building structures, liquid oxygen for aircraft use, turbulent boundary layer investigations, flood waves, the development of aeronautical instrumentation of various kinds, and others.

Electricity and Optics (F. B. Silsbee, chief): Projects in electricity include standards of direct capacitance of very small magnitudes, electrical surge measurements, underground corrosion, batteries and dry cells, magnetic measurements, and basic research in the field of resistance, inductance, and capacitance standards and measurements. Work in optics includes a wide variety of investigations in spectroscopy, interferometry, photometry, colorimetry, polarimetry, and optical instruments.

Atomic Physics (E. U. Condon, chief): Work in this field includes tracer micrography, the compilation of atomic energy levels, the development and calibration of beta-ray standards, the preparation of microgram radium gamma-ray standards, investigations of radiation hazards, X-ray protection barriers, the action of penetrating radiation on biological matter, and other basic research in atomic and subatomic physics.

Heat and Power (F. G. Brickwedde, chief): Basic work in thermodynamics, including cryogenics and temperature measurement, automotive and aircraft engines, and lubricants and fuels is conducted. Typical projects involve the analysis of recycle styrene, aviation gasoline hydrocarbons, high-altitude brush wear, jet boring tools, pyrometers for gas turbines, heat capacity of certain gases, and others.

Metrology (W. Souder, chief): Basic length, mass, time, and capacity and density measurement, instrumentation, and standards problems constitute the bulk of activity. New secondary standards of mass, precision plain ring gages, and angle gage blocks, surface strain in plastic dentures, flow nozzles, precision ruling of circles, and thermal expansivity are some of the projects carried on.

Chemistry (G. E. F. Lundell, chief): A wide range of work in organic, analytical, and physical chemistry is performed, including carbon monoxide indicators, heats of formation of certain hydrocarbon compounds, fractionation and analysis of hydrocarbons in petroleum, standard samples of hydrocarbons, benzoic acid thermometric standard, and electrodeposition.

Organic and Fibrous Materials (A. T. McPherson, chief): High polymer research includes studies of the viscosities of dilute solutions of high polymers in solvent-precipitant mixtures, shape of long chain molecules, copolymerization reactions, and the interaction between polymers and liquids. Other typical projects include research on synthetic and natural rubbers, cellulose and cellulose derivatives, water-repellent fabrics, resin-bonded plywood, and performance of plastics.

Mineral Products (H. Insley, chief): Applied and fundamental research is conducted in porcelains, pottery, glass, refractories, enameled metals, concreting materials, masonry and reinforced concrete, lime and gypsum, and building stone. Specific investigations include ceramic coatings for high-temperature protection of low-carbon steel, concretes containing admixtures, exposure of concrete, new optical glasses, wool fibers, and the constitution of mineral products.

Metallurgy (J. G. Thompson, chief): Many studies in ferrous and nonferrous metallurgy are conducted, e.g. influence of boron on steels for armor plate, repair of porous castings, preparation of magnesium castings, resistance to corrosion of light metals for aircraft, stabilization of chromium-nickel steels, basic principles of powder metallurgy, X-ray metallography, and studies of gases in metals.

Building Technology (D. E. Parsons, chief): Simultaneous investigations of the properties of building materials, structural strength, fire resistance, acoustics and sound insulation, heating, ventilating, and air conditioning, durability and the exclusion of moisture, building and electrical equipment, and miscellaneous projects in the building field are carried on.

On Wednesday, September 15, those attending the Centennial Celebration will have an opportunity to tour the Bureau and other laboratories engaged in work in the physical sciences.

NEWS and Notes

Herbert R. Morgan has been appointed associate professor of epidemiology in the Section of Public Health Laboratory Practice, School of Public Health, and assistant professor of internal medicine in the Medical School at the University of Michigan. Dr. Morgan has recently been working as senior fellow in virus diseases, NRC, at the Thorndike Memorial Laboratory of the Boston City Hospital.

Hugh W. Terhune, administrator of the Philippine Fishery Program of the Fish and Wildlife Service, has been appointed honorary adviser on fisheries to the Philippine Government by President Elipidio Quirino. In 1946 he was appointed to organize and administer the Philippine Fishery Rehabilitation Program.

Robert J. Wherry, vice-president of Richardson, Bellows, and Henry, consulting psychologists, has been appointed to the staff of Ohio State University's Psychology Department, effective October 1.

Arthur Bevan, principal geologist of the Illinois Geological Survey and chairman of the Division of Geology and Geography, National Research Council, is continuing during August his field research on the Pleistocene glaciation and geomorphic evolution of the northern Rocky Mountains. The customary field work in Montana will be supplemented this season by special studies in western Alberta and eastern British Columbia.

William E. Gordon, former research consultant for the Minneapolis Regional Office of the Social Security Administration, was recently appointed professor of research at the Nashville School of Social Work, graduate school for professional social workers which is operated cooperatively by Vanderbilt University and Scarritt and Peabody Colleges.

Walton B. Sinclair, staff member of the Division of Plant Physiology at the University of California Citrus Experiment Station, Riverside, for the past 15 years, was recently named head of the Division. Prof. Sinclair succeeds **E. T. Bartholomew,** head of the Division since 1935, who has retired.

Victor A. Drill was recently appointed professor of pharmacology at Wayne University College of Medicine. In his new position Dr. Drill is continuing his previous research in pharmacology and metabolic problems.

Robert M. Chew, of the University of Illinois, has been appointed to the staff of Lawrence College, Appleton, Wisconsin, as assistant professor of biology, effective in September.

Nephi Albert Christensen, dean of engineering at Colorado State College,

has been named director of the School of Civil Engineering at Cornell University, effective in September. Dr. Christensen will succeed **Carl Crandall**, who has served as acting director since the death of the late director, **William Lindsay Malcolm**, in January.

Alfred H. Nadelman, technical superintendent and chemist for the International Paper Company, will become head of the new pulp and paper technology curriculum to be inaugurated at Western Michigan College (Kalamazoo) in September.

Jorgen M. Birkeland, faculty member of Ohio State University since 1935, has been named head of the Bacteriology Department. Prof. Birkeland succeeds **William A. Starin** who has retired from his teaching duties after 38 years on the Ohio State staff.

Carl A. Lawrence, who has been director of the Bacteriological Control and Research Division of Winthrop-Stearn, Inc., since 1938, has been appointed assistant professor of bacteriology in the Medical School of the University of Michigan for the University year 1948–49.

Grants and Awards

Eugene J. Houdry, of Ardmore, Pennsylvania, will be the recipient of the 1948 Potts Medal from The Franklin Institute at the traditional Medal Day ceremonies in Philadelphia on October 20. Richard T. Nalle, president of the Institute, will present the medal to Mr. Houdry "in consideration of his leadership in the development of catalytic cracking of petroleum that bears his name."

The Arctic Institute of North America recently announced the availability of an increased number of senior grants-in-aid for scientific work in the North American Arctic and Subarctic during 1949. Conditions remain the same as for the original grants-in-aid offered (see *Science*, May 21, 107). The grants-in-aid, which stipulate field investigations either in Alaska, northern Canada, Labrador, Newfoundland, or Greenland, are open to anyone who has demonstrated his ability to do research of superior quality in some field of science. Applications must be received by November 1, 1948. Forms may be obtained from: The Arctic Institute of North America, 805 Sherbrooke Street West, Montreal, Canada, or Audubon Terrace, Broadway and 156th Street, New York 32, New York.

Colleges and Universities

The University of Nebraska Foundation has received from Mrs. Marybeth N. Brown, of Niagara Falls, New York, a gift of $93,000 to establish "The Mortimer Jay Brown Memorial Fund," in memory of her husband, who died on April 7, 1945. Income from the fund will be used for any or all of three general purposes in the field of chemistry: (1) graduate fellowships for basic or industrial research; (2) strengthening faculty competence in chemistry where the usual means for obtaining competence are not adequate; and (3) purchase of specialized equipment. Dr. Brown, a native Nebraskan, graduated from Nebraska in 1905 with a B.Sc. degree. He joined the research staff of Roessler & Hasslacher Chemical Co. in 1911 and was vice-president in charge of research at the time of his retirement in 1932.

The Department of Metallurgy, Massachusetts Institute of Technology, under a recent grant from the AEC research division, is currently expanding its studies on the application of radioactive tracer techniques to mineral engineering problems. The new program, to extend over a period of years, is expected to be of special value to the mineral industry and in the training of engineers in the use of radioactive tracers.

The advisory board directing the new project will consist of Antoine M. Gaudin, acting as supervisor; Bruce Old, of Arthur D. Little, Inc., and the AEC; Reinhardt Schuhmann, Jr.; John Dasher, of the Division of Industrial Cooperation; Robley D. Evans, Department of Physics; John W. Irvine, Department of Chemistry; and Martin J. Buerger, Department of Geology. H. Rush Spedden will act as executive officer.

Cornell University recently named the herbarium of its Department of Botany "The Wiegand Herbarium of Cornell University," in honor of the late Karl M. Wiegand, formerly head of that Department.

The Physics Department, Stanford University, has announced a number of personnel changes for the new academic year. Leonard I. Schiff, formerly associate professor, has been made professor and acting executive head of the Department. Paul H. Kirkpatrick, on sabbatical leave, will do research work at Stanford and Southern California, later serving as visiting professor at Bowdoin College for the spring term. Myron A. Jeppesen, on leave of absence from Bowdoin, has been appointed visiting professor of physics. W. Carl Barber, University of California graduate, and Martin E. Packard, Oregon State University, have been named instructors.

Meetings

The U. S. Delegation to the 8th General Assembly of the International Union of Geodesy and Geophysics, to be held in Oslo, August 17–28, has been announced by the Department of State to consist of the following: Walter D. Lambert, chief, Section of Gravity and Astronomy, U. S. Coast and Geodetic Survey (chairman); Leason H. Adams, director, Geophysical Laboratory, Carnegie Institution; K. Hilding Beij, assistant director, Hydraulics Laboratory, National Bureau of Standards; Francis W. Reichelderfer, chief, U. S. Weather Bureau; and Waldo E. Smith, executive secretary, American Geophysical Union. It is expected that approximately 31 countries will participate in the Assembly. Among the subjects to be covered by papers presented at the meeting are physical aspects of the influence of solar activity on terrestrial magnetism, the ionosphere, magnetic surveys and instruments, airborne magnetism, terrestrial magnetism, and aurora.

The 1948 National Industrial Chemical Conference and National Chemical Exposition will be held concurrently at the Chicago Coliseum, October 12–16. Sponsored by the Chicago Section of the American Chemical Society, the program will include papers by leading authorities on sub-

jects of interest to all industrial executive and technical personnel. Topics for discussion include "Chemical Markets," "Chemistry in General Industry," "Hazards From Chemicals," "Management of Research," "Frontiers of Chemistry," and "Pilot Plant Use by the Chemical Industry." Special exhibits of interest to chemical workers will also be included.

A new feature of the Exposition this year will be a Technical Bureau manned by Ward V. Evans, retired chairman of the Chemistry Department at Northwestern University and now professor of chemistry at Loyola University. The Bureau is designed to assist firms which find it profitable to use industrial chemistry in their production and operation. Chemical Trail Blazers, which has been a popular feature of past Expositions, is to be repeated this year on an even larger scale.

Advancing Textiles Through Research will be the theme of the 27th national convention of the American Association of Textile Chemists and Colorists, to be held at the Sheraton Bon Air Hotel in Augusta, Georgia, October 21–23. In addition to a general technical meeting, which will take the form of a Cotton Symposium under the chairmanship of R. W. Philip, of the Research Division, Callaway Mills, LaGrange, Georgia, a series of technical papers will be presented at meetings of the Testing and Auxiliaries Group, the Textile Printing Group, the Noncellulosic Fibers Group, and the Hosiery Group. The presidential address will be given on the evening of October 23 by Henry F. Herrmann, of the General Dyestuff Corporation, New York City.

Deaths

James Alexander Miller, 74, authority on tuberculosis and former professor of clinical medicine at the College of Physicians and Surgeons, Columbia University, died at his Black Point, Connecticut, home on July 29, following a brief illness. At one time Dr. Miller served as president of the National Tuberculosis Association and had also headed the American College of Physicians.

John Marcus Evvard, 63, research scientist and author, well known for his work in the development of iodized salt, died in Phoenix, Arizona, on July 30. Dr. Evvard had served for many years as a consultant on animal nutrition and production. He was at one time a special assistant in the Office of the Secretary of Agriculture and later became professor and head of the Department of Agriculture at Arizona State College.

A complete copy of the 2,500-year-old carved order of King Darius of Persia, known as the "Rosetta Stone of Western Asia," will be made starting in October by George G. Cameron, leading an archaeological expedition sponsored by the University of Michigan and the American Schools of Oriental Research. Dr. Cameron, an associate of the Oriental Institute of the University of Chicago for 15 years, joins the University of Michigan faculty in September in an on-leave capacity until the completion of the Iranian project.

Two previous expeditions have made partial examinations of the Mount Behistun inscriptions. Dr. Cameron plans a re-examination of all the doubtful passages in these Elamite, Old Persian, and Babylonian inscriptions, together with a study of four additional columns of inscriptions which have never been read due to their inaccessibility. Expedition members will be lowered from a natural shelf, 300 feet above this sculptured panel, by means of steel cable and a scaffold. The cable and scaffold will also be used while a cast of the relief is prepared for a permanent replica to be housed in the Museum of Archaeology at the University of Michigan.

The Office of Education, Federal Security Agency, recently made available a 28-page directory of 600 sources of 16-mm films for teachers and school administrators. The directory, entitled "A Partial List of 16-mm Film Libraries," is available without cost from the Visual Aids Section of the Office of Education, FSA, Washington 25, D. C.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, is currently interested in obtaining the following chemicals: 2,2-difluorohexane, oleanolic acid, samogenin, gitogenin, ethionic acid, bicyclo(2,2,1)-2-heptene, D-lupanine hydrochloride, titanium dichloride, boron sulfide, benzyl fluoride, petroselinic acid, uridine, xanthylic acid, inosinic acid, scandium, smilagenin, mexogenin, isopelletierine, and tungsten carbonyl.

Correction: It has been called to our attention that our announcement of the granting of the Third Intermediate Sugar Research Foundation Award to Leslie F. Wiggins (*Science*, May 14, p. 502) was incorrect in several respects. The Imperial College of Tropical Agriculture, mentioned in the item as being located in Kingston, Jamaica, and as having been "recently created," is actually located in Trinidad, B.W.I., and has been in existence for 27 years. We learn that it was founded as the West Indian Agricultural College in 1921 and that its name was changed to its present one in 1924. It was also stated in the announcement that Dr. Wiggins had been appointed research director at the College. His appointment was as director of sugar research under a new Sugar Research Scheme launched in 1947. We regret that these misstatements occurred.

Make Plans for—

American Society of Agronomy and Soil Science Society of America, annual meetings, August 24–27, Fort Collins, Colorado.

American Association of Blood Banks, first annual meeting, August 26–28, Hotel Statler, Buffalo, New York.

7th International Congress of Applied Mechanics, September 5–11, Imperial College of Science and Technology, South Kensington, London, England.

Mathematical Association of America, 30th summer meeting, September 6–7, University of Wisconsin, Madison.

Meteoritical Society, September 7–8, Institute of Meteoritics, University of New Mexico, Albuquerque.

International Rheological Congress, organizational meeting, September 21–24, Scheveningen, Holland.

Comments and Communications

Important Advances in Zoological Nomenclature Achieved at 13th International Congress of Zoology

During the 13th International Congress of Zoology, which closed at Paris on Tuesday, July 27, the International Commission on Zoological Nomenclature, holding its first meeting since the close of the war, put forward a comprehensive program for the reform and development of zoological nomenclature. All 13 of the Commission's meetings were open to all the members of the Congress, who were thus enabled to take an active part in the discussion of the proposals put forward. As a result, it was possible not only to obtain decisions on a much larger number of questions than would otherwise have been practicable but also to ascertain much more readily the needs and general wishes of zoologists. The scheme finally adopted was approved unanimously by the Section on Nomenclature and, on the recommendation of the Section, by the Congress itself at its final plenary session.

Prior to the opening of the Paris meeting, extensive discussions had been undertaken by the Commission with leading scientific institutions and individual specialists in different parts of the world, with the double purpose of drawing up a scheme which would ensure for the Commission the highest possible representative and international character and assure that at the Paris meeting all practical measures would be taken to improve and develop the *Règles Internationales de la Nomenclature Zoologique.*

Measures taken to secure a fully representative and international character for the Commission. Hitherto the International Commission has had a fixed membership of 18 Commissioners, but in the future there will be no fixed upper limit to its membership, though the number of 18 will be retained as the minimum membership. Under the new system it will be possible, therefore, for the zoologists of any country in which any considerable body of zoological work is being carried out to have a direct representation on the Commission. The change now made will make it possible also for the Commission to call to its membership leading specialists in particular fields, irrespective of country. Machinery is at the same time provided for consultation with the leading scientific institutions in any country in regard to the selection of its representative on the Commission.

Measures taken to reform the procedure of the Commission. The extensive series of changes in the procedure of the Commission are designed to secure that in the future the Commission shall be able to reach decisions much more rapidly than has been possible in the past. The most important single reform is the abandonment of the *Liberum Veto,* under which either during a meeting or when business is conducted by correspondence a single member of the Commission could prevent any decision being taken by the Commission either in the formulation of recommendations for the improvement of the *Règles* or in the use of the plenary powers given to the Commission to conserve zoological names which are in common use but are technically defective. Other reforms agreed upon are designed to eliminate all unnecessary delay in the consideration of nomenclatorial problems submitted to the Commission by specialists. It is hoped that under this revised procedure it will normally be possible for the Commission to promulgate its decision on any question put to it within 18 months of the date of the application.

Reform and development of the Règles. At the opening of the Paris meeting the *Règles* in force were substantially the same as those adopted at the Congress of Zoology held at Berlin in 1901. The object of the reforms now agreed upon is to clarify the text of the *Règles,* which experience has shown to be in many cases obscure, to make the *Règles* more comprehensive by introducing provisions on questions not hitherto included in that instrument, and, where necessary, to introduce changes into the *Règles* in order to bring their provisions into harmony with the general wish. By these means it is hoped to retain everything that experience has shown to be valuable in the *Règles,* to eliminate all those passages which have been found to be unsatisfactory, and to meet the needs of zoologists by the introduction of provisions on matters which have hitherto not been subject to international regulation.

Codification of the international law on zoological nomenclature. A large part of existing international law on zoological nomenclature is to be found not in the *Règles* themselves but in "Opinions" rendered by the International Commission acting in the judicial capacity entrusted to it by the International Zoological Congress at Boston in 1907. The complex body of case law which has thus grown up over the last 40 years has made the task of zoologists extremely difficult. A wide welcome will therefore be given to the decision now taken in Paris to codify the law by incorporating in the *Règles* themselves the decisions hitherto embodied only in the "Opinions" of the Commission. Another reform of great practical value is afforded by the decision to record in special Schedules attached to the *Règles* the decisions taken by the Commission in particular cases. With regard to decisions to be taken by the Commission in the future, these will be of either of two kinds: (1) decisions on matters of principle, which will be issued as *Declarations* and take the form of proposed amendments to be incorporated in the *Règles* after approval by the next Congress, and (2) decisions on individual cases, which will be issued as *Opinions* and which, after the next Congress, will be inserted in the appropriate schedule to the *Règles.* Thus, the Commission intends to ensure that in the future a zoologist will be able to find the whole body of international law in regard to zoological nomenclature within the covers of a single volume.

Preparation and promulgation of the revised substantive French text of the Règles. Recognizing the highly technical problems inevitably involved in the

preparation of a substantive text giving effect to the numerous changes which have now been agreed upon, the Congress, on the advice of the Commission, has decided that this task shall be entrusted to jurists before whom the decisions of the Congress will be laid. The text prepared by the jurists will be submitted to the members of the Commission for final approval, and the task of considering any drafting points which may emerge from the foregoing consultation has been entrusted to a special committee of three consisting of: Francis Hemming (United Kingdom), secretary to the Commission, Dr. van Straelen (Belgium), and Prof. Robert E. Usinger (U. S. A.).

Contrasted provisions for dealing with old names and new names. The *Règles* in their amended form will come into operation immediately they are promulgated. Meanwhile, arrangements are being made for the publication as soon as possible of the *Procès Verbaux* of the Commission during its Paris meeting in the Commission's *Bulletin of Zoological Nomenclature.* In general, it will be found that, in order to ward against the risks involved in retroactive legislation, the provisions relating to names already published are simpler and less rigorous than those to be applied to names to be published in the future. From now on workers giving new names will have at their disposal rules which are simple, clear, and easy to operate. The position with respect to names already published—and especially names published before the introduction of the *Règles* 50 years ago—will necessarily be rather more complicated. It is hoped, however, that, with regard to generic names, these difficulties will be largely overcome by a rapid and substantial extension of the "Official List of Generic Names in Zoology," for under the arrangements now agreed upon, a name once placed on this List is not to be changed for any purely nomenclatorial (as contrasted with taxonomic) reason without the prior approval of the International Commission. A similar provision has been made with regard to the trivial names of species, and for these also there has now been established an "Official List" of names which are not in the future to be changed for purely nomenclatorial reasons without the prior approval of the Commission. The establishment of these two "Official Lists" makes it possible for specialists in any group to concert proposals for submission to the Commission for the insertion on these "Official Lists" of the names of the genera and species in their group and thereby to protect those names from changes for any reason other than taxonomic considerations.

The value of preliminary studies on particular problems. The work of the present meetings was greatly assisted on two important matters by the decision taken at the previous Congress (held at Lisbon in 1935), that before the present meeting a detailed study should be made on two important questions of nomenclature which had been a cause of difficulty for many years. In each case the reports so submitted to the Paris meeting provided the basis for an agreed settlement. The first of these reports was concerned with the meaning of the expression "nomenclature Binaire" as used in the *Règles.* In this case the Commission and the Congress have agreed to substitute the expression "nomenclature binominale" for the expression referred to above, subject to the incorporation of safeguards for generic names published by "binary" though not binominal authors. The second of these reports was concerned with the problem of the nomenclature of forms of less than subspecific rank, a matter on which no provision had hitherto been made in the *Règles.* In this case also the report submitted provided the basis for an agreed settlement. The Commission and the Congress have been so much impressed by the value of this procedure that they have now agreed that similar Reports should be prepared for consideration at the next Congress in regard to other difficult problems, including (1) the treatment of Family names, (2) the nomenclature of Orders and higher groups, (3) the rules which should govern the emendation of names, and (4) the problems presented by the demand for the recognition of "neotypes."

Settlement of outstanding individual cases. Owing to the war and other causes the Commission, at the beginning of its Paris meeting, was confronted with heavy arrears of work in connection with individual applications submitted to it by specialists in different parts of the world. During the recent meeting decisions were taken on almost all of these cases, and these decisions will be promulgated in the near future.

The future outlook. The effect of the reforms in the *Règles* instituted during the Paris meeting will be to provide zoologists with a system of law which will be much easier to operate and will ensure stability and uniformity in the nomenclature. At the same time the reforms in the constitution of the Commission and its procedure will assure to zoologists a central authority with regard to all matters relating to zoological nomenclature far more representative and international than ever before and, as such, capable of providing a service more extensive and of much greater value than has been possible at any previous time.

FRANCIS HEMMING, *Secretary*

Water at – 72° C

Reports by McCracken (*Science,* November 7, 1947, p. 453) and Rabel (*Science,* May 28, p. 567) prompt the writer to describe a demonstration experiment which he has been using for some years to illustrate the undercooling of water. A freezing mixture of shaved ice and alcohol is prepared, the temperature of which is carefully measured to be between – 5° and – 7° C, and placed in a wide-mouthed, 500-cc vacuum bottle. A 7- to 10-cc test tube three-quarters full of tap water is placed in the freezing mixture and agitated, with a thermometer as a stirring rod, until the temperature is just below + 4° C. Agitation is then stopped, and almost invariably the water temperature falls to the subzero temperature of the freezing mixture. The test tube is then removed from the freezing mixture and shown to the class; a single rapid shake of the test tube suffices to initiate freezing with the attendant rise in temperature to 0° C—which the experiment is primarily intended to demonstrate.

If the freezing mixture is lower than −7° C, freezing usually sets in at 0° C, and if the mixture is warmer than about −5° C, the water in the test tube undercools, but usually does not freeze when agitated, and will remain in the undercooled condition indefinitely.

The thermometer used in this experiment is a pair of copper-constantan junctions in a thin-walled glass tube, with a wall galvanometer indicating the current, which is roughly proportional to the relatively small temperature differences.

Rabel's suggestion that the "freezing nuclei" are "active . . . between 10° and 12°" seems to be borne out by this experiment. If the "10° and 12°" means +10° C and +12° C, then the agitation probably inhibits the action of the nuclei; if −10° C and −12° C is meant, then freezing does not take place, because this range of temperature is avoided by keeping the freezing mixture substantially warmer.

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In a recent communication under this same title (*Science*, May 28, p. 567), Gabriele Rabel called attention to an important paper by Walter Rau (*Schriften der deutschen Akademie fuer Luftfahrtforschung*, 1944, Vol. 8, Pt. 2, pp. 65–84) in which is reported the supercooling of water to −72° C. Two striking and very pertinent observations made by Rau were, however, not mentioned.

Rau reported that the ice that formed at −72° C melts near −70° C, and that occasionally he had observed freezing near −55° C, yielding ice that melted below −40° C. Obviously, neither of those ices is ordinary ice (Ice-I). He gives reasons for inferring that the −72° C ice is Bridgman's Ice-VI and thinks that the −55° C ice is one of the other ices that have been observed under pressure.

His observations indicate that, in the absence of motes of some kind in the water, ordinary ice never forms spontaneously. That accords with the conclusion drawn by the writer 10 years ago in a preliminary report (*J. Res. nat. Bur. Stand.*, 1938, 20, 799–808 (RP1105)) in which it was shown that the observations are consistent with the idea that the size of the mote is a very important factor. Much additional data—none lower than −22° C—confirming that conclusion have been obtained since then. They and a new theory of the initiation of freezing are given in a forthcoming paper (*Trans. Amer. phil. Soc.*, 38, Pt. 3).

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Gabriele Rabel's note on "Water at −72°" (*Science* May 28, p. 567) summarizes Walter Rau's work on undercooled water. It should be noted that Dr. Rau's work has been severely criticized by B. M. Cwilong in "Observations on the Incidence of Supercooled Water in Expansion Chambers and on Cooled Solid Surfaces" (*J. Glaciology*, 1, 53–57). Cwilong points out that Rau's phenomena are not reproducible unless some contaminant such as ether or acetone is present in the system.

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Low-Temperature Spectroscopy of Biological Compounds

Scott, Sinsheimer, and Loofbourow (*Science*, March 19, p. 302) have given a method of rendering more characteristic absorption spectra of polar organic compounds by cooling. Aqueous solutions of such compounds naturally cannot be investigated below 0° C. The new method involves cooling of thin solid films consisting of the pure substances.

It may be useful to draw attention to an alternative method (Broda and Goodeve. *Proc. roy. Soc.*, 1941, **A179**, 151), which was successfully applied to the optical and photochemical investigation of the polar compound (conjugated protein), visual purple, at the temperature of solid CO_2. Visual purple, like many other polar compounds, is soluble in glycerol. The solution, when chilled, vitrifies without crystallizing and therefore remains homogeneous and clear. The absorption spectrum of the visual purple sharpened very considerably. The glycerol method would no doubt prove valuable with other polar bodies.

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On the Purification of Rabies Vaccine

Rabies vaccine made from the brain and cord of rabbits is a mixture of inert and of antibody-producing fractions. The effect of removal of an inert portion upon the immunizing value of the residual has been studied, and the result warrants a brief report.

Fats and lipoids, extracted from desiccated vaccine (*J. inf. Dis.*, 1912, 10, 369–377; 1913, 13, 155–164) with various solvents and injected into mice, do not confer protection or provoke evidence of toxic response when given subdurally or intraperitoneally. Lipids may be removed with ether, chloroform, acetone, or xylol, but in the process much or all of the living virus may be killed. But when the extraction is made at a low temperature (−65° C) with a petroleum ether of low boiling point (20°–40° C), the virus is not destroyed nor is its antigenic value impaired. Tests of the residue made one year after the extraction show the amount of living virus to be as large as in an untreated sample of the same lot.

Comparative tests also show there is no significant loss in immunizing value. The results justify the conclusion that immunity is effectively established earlier with this fraction than with the whole. A single intraperitoneal injection has resulted in the protection of Swiss mice against a challenge of 1,000,000 times the LD for unprotected mice.

Experiments to determine accurately the value of the lipid-free fraction under variation of time and temperature are continuing and will be the subject of a later report.

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TECHNICAL PAPERS

Color Adaptation to Stimuli of Different Spectral Composition But Equal Tristimulus Values

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Color adaptation experiments using the color adaptometer have been previously reported (*1*). It has been found that the results of extensive experiments may be predicted by the use of three general laws:

(I) The course of color adaptation consists of a gradual, but never complete, loss of saturation, with no change in hue, and an increase in intensity.

(II) The rate and degree of desaturation depend upon the hue, relative intensity, and relative saturation of the stimulus color.

(a) The loss of saturation is most rapid for a green stimulus, less for a red stimulus, and least for a blue stimulus.

(b) The less intense the stimulus, the greater the loss of saturation.

(c) The less saturated the stimulus, the more rapid is the initial rate of desaturation; the equilibrium position, or point of lowest desaturation, is independent of the saturation of the stimulus.

(III) The rise in intensity is dependent on the saturation and intensity of the stimulus and independent of the hue of the stimulus.

(a) If the saturation and intensity of the stimulus are both high or both low, the rise in intensity will be greater than if one is high and the other is low.

In a summary of the color adaptation literature (*2*), it was shown that, among the approximately 40 previous investigators, there is very little agreement. This situation may have been brought about by the fact that most investigators describe their stimuli in terms of tristimulus values, *i.e.* the color as it appears to the observer, and not in terms of spectral composition. Colors which look alike may be composed of vastly different physical radiations. Although the retina is being stimulated by different wave lengths, if the two sets of radiations bear certain mathematical relationships with each other, the two stimuli will appear to be identical. Color theories predict this mathematical relationship, but only under standard conditions, and tell us nothing concerning the peculiar integrating mechanism involved. It may be that the adaptation phenomenon is dependent not on the color as it appears but on the particular receptors which chance to be stimulated.

In testing experimentally the hypothesis that the color adaptation of the eye is a function of the spectral composition of the stimulus and not of the tristimulus values of the stimulus, we propose to plot curves of the adaptation function (similar to those in *1*, pp. 103–105), by use of our color adaptometer, to two stimuli equated with respect to tristimulus values but with different spectral composition.

Two filters,[1] the spectrophotometric curves of which are shown in Fig. 1, were obtained. The color of these

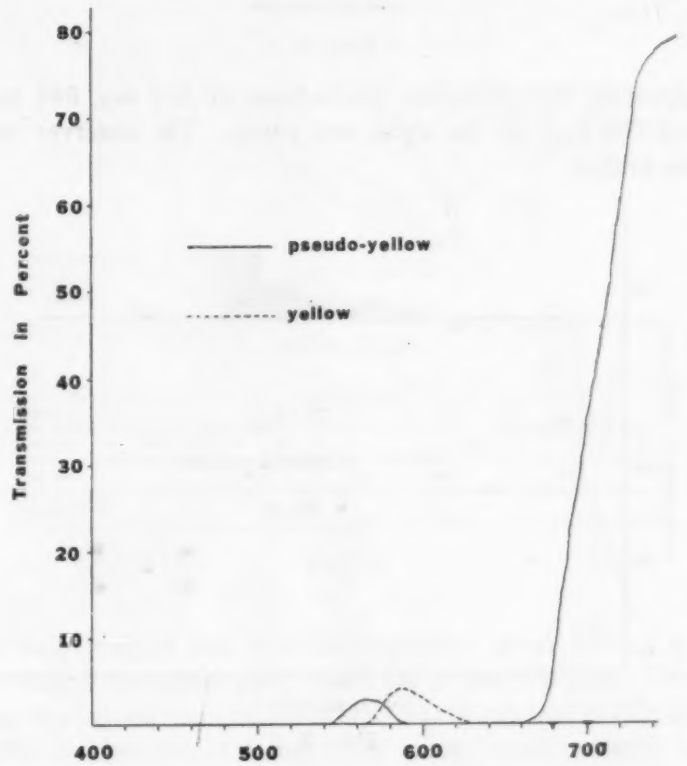

FIG. 1. Spectrophotometric curves of the filters used as stimuli. The curves integrate to give equal tristimulus values.

filters is yellow; their transmissions are, however, quite different. The filter having most of its radiation at 580 mμ is termed 'yellow'; the other is termed 'pseudo-yellow.' If the red filters are removed from the filter holders in front of the left continuous source in the color adaptometer (see *1*, p. 93) and either the yellow or pseudo-yellow filter placed in the filter holder, the left test patch will appear yellow to the observer. If the color temperature of the left continuous source be adjusted, the resulting yellows may be made to look exactly alike.

The yellow and pseudo-yellow filters were placed one at a time in the filter holder and two sets of adaptation curves obtained by the procedure previously explained (*1*, pp. 100–101), wherein the observer matches the color seen on the left test patch at various time intervals by

[1] The writer is indebted to H. P. Gage, of the Corning Glass Works, for the loan of these filters and to David L. MacAdam, of the Eastman Kodak Company, who was kind enough to furnish a number of sets of Wratten filters with similar characteristics.

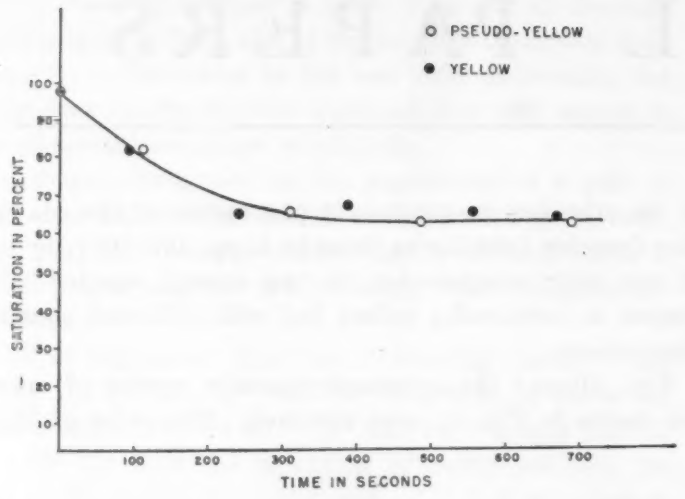

FIG. 2

adjusting the primaries (radiations at 436 mμ, 546 mμ, and 700 mμ) of the right test patch. The observer was the author.

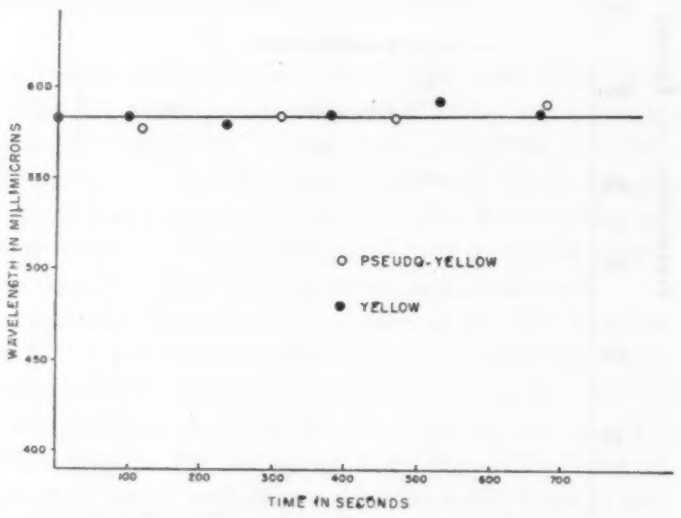

FIG. 3

Figs. 2, 3, and 4 give the resulting curves for both the yellow and pseudo-yellow filters. Fig. 2 indicates the loss of saturation for both stimuli; Fig. 3, the constancy

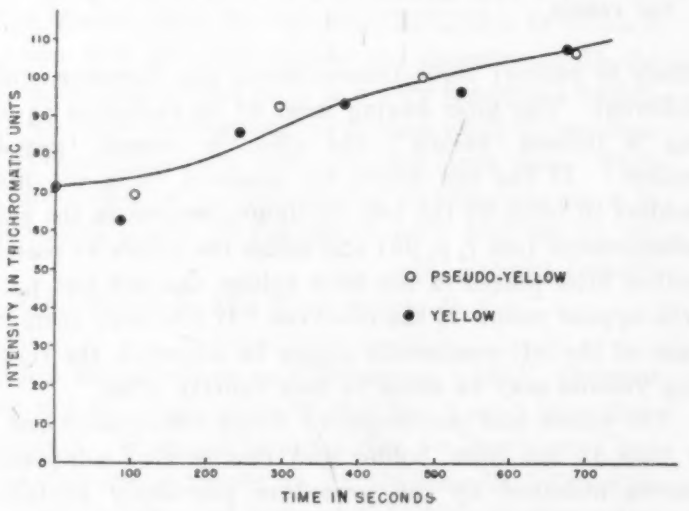

FIG. 4

of hue for both stimuli; and Fig. 4, the gain in intensity for both stimuli.[2]

[2] These results are not to be compared with our previous curves (*1*, pp. 103–105), since no attempt was made to equate these stimuli with those used before.

The divergence of the yellow and pseudo-yellow curves appears to be well within the experimental error, and we conclude that, as far as our experimental work has gone, the color adaptation phenomenon is a function of the tristimulus values of the stimulus and not of the spectral composition of the stimulus. There is, of course, an internal check. If the filters are placed one on either side of the colorimeter so that the observer may fixate the yellow and pseudo-yellow stimuli simultaneously, then, although the colors appear to change with time, they should always look alike. This has been done, and, indeed, the colors always do look alike.

The eye has always failed to resolve a stimulus into its components and it has here failed again. But we wonder about a mechanism which is so complex that it always fulfills this ideal, even under the most elaborate experimental conditions. It constitutes the great enigma of color vision.

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Chloromycetin in the Treatment of Scrub Typhus[1]

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The antibiotic Chloromycetin (*1*) has been shown to have a beneficial chemotherapeutic effect when administered to mice or embryonated eggs infected with a number of rickettsial agents (*3*) or with two viruses of the psittacosis-lymphogranuloma venereum group (*4*). The drug is rapidly absorbed when given by mouth to human beings and readily reaches concentrations in the blood of the order of 40 γ/cc (*2*). No obvious toxic effects attributable to the drug have been observed in the normal men or the patients who have been studied to date. A report of the encouraging results observed in a few cases of epidemic typhus who were treated with Chloromycetin early this year in Mexico has been submitted (*5*).

Methods commonly employed in the ward and clinical laboratory were used in most of the work. Mice were inoculated intraperitoneally with defibrinated blood cells from the patient in attempts to demonstrate rickettsemia. Results were considered positive when mice of the original

[1] Read before the Section on Virus and Rickettsial Diseases, Fourth International Congress on Tropical Medicine and Malaria, May 11, 1948.

or one of the subsequent passage groups showed typical lesions of scrub typhus and provided material in which rickettsiae were demonstrated microscopically. Chloromycetin was supplied by Parke, Davis and Company.

Twenty-five persons with scrub typhus were treated with Chloromycetin. Each of these presented the usual clinical features of the disease. Furthermore, the diagnosis was proved in each instance by recovering *Rickettsia tsutsugamushi* from the blood taken prior to treatment or by demonstrating the development during convalescence of agglutinins for the OX-K strain of *B. proteus*. Rickettsemia occurred in 20 of the 25 patients in the treated group, and a positive Weil-Felix reaction in 24 of this group. All 12 of the control cases gave positive Weil-Felix reactions.

Statistical data on the treated and untreated groups of patients are summarized in Fig. 1. None of the treated group developed complications attributable to the disease or to the drug, and none died. One patient who received Chloromycetin on the 3rd day was discharged from the hospital for light work on the 9th day after onset. The first patient in the group was held for observation in the hospital for 28 days.

Twenty-two of the 25 treated cases derived their infections from exposures in areas within a radius of 20 miles of Kuala Lumpur. Eleven of the 12 untreated cases of scrub typhus who were observed during the period also contracted their disease within this general area. Indeed, 5 of the 12 controls became infected while working in precisely the same spots which provided 14 patients of the

SCRUB TYPHUS PATIENTS
KUALA LUMPUR, 1948

	TREATED	UNTREATED
Nº OF PATIENTS	25 18 MALES 7 FEMALES	12 ALL MALES
DAY AFTER ONSET R. BEGUN	3 TO 11 AV. 6.2	
LAST FEBRILE DAY OF ILLNESS	4 TO 12 AV. 7.5	13 TO 29 AV. 18.1
DURATION OF FEVER (HRS) AFTER R. BEGUN	10 TO 96 AV. 31.0	
DAY AFTER ONSET DISCH'D FROM HOSP.	9 TO 28 AV. 19.2	17 TO 53 AV. 30.7
COMPLICATIONS	0	1 PAROTITIS 1 PNEUMONIA
DEATHS	0	1 17TH DAY
MONTH OF ONSET	MAR – APR	FEB – MAR

FIG. 1

treated group. Hence, one may assume that the strains of rickettsiae which infected the treated and control groups were fairly comparable in virulence. The test and control groups may also be assumed to be comparable with regard to capacity of the individuals to overcome infection with *R. tsutsugamushi*. Thus, the age distribution and the distribution of Europeans, Malays, Indians, and Chinese among the controls were similar to that of the treated group. The sharp contrast in the clinical responses of the two groups is clearly evident from the data summarized in Fig. 1.

The typical response of a patient with scrub typhus following treatment with Chloromycetin is illustrated by Case 4, whose findings are graphically presented in Fig. 2.

All 25 patients in the treated group received an initial oral dose of approximately 50 mg of Chloromycetin/kg

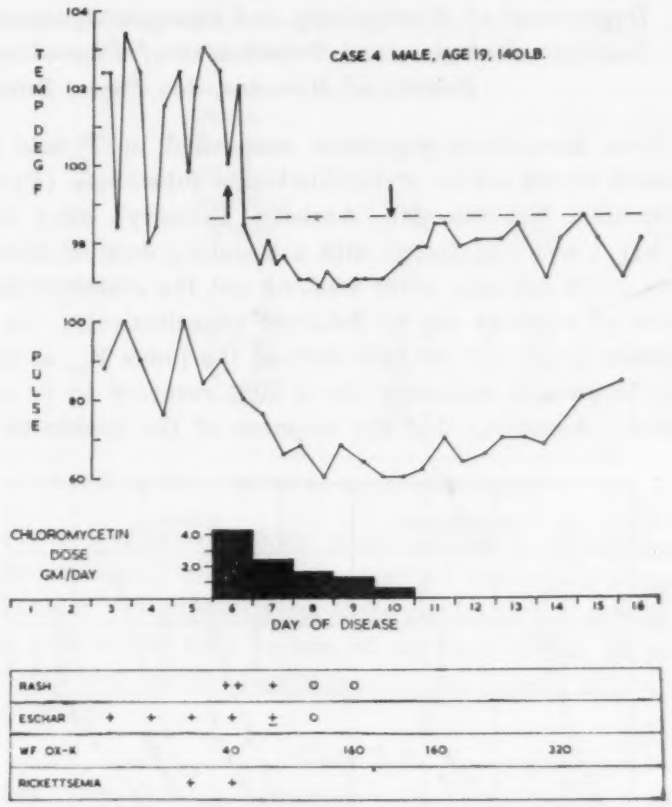

FIG. 2

of body weight and were subsequently given 0.2–0.3 gm of drug by mouth every 2–4 hrs for a variable time. During the initial part of the work, treatment was continued until at least the 12th day after onset; these patients received totals of 8–15.5 gm of drug. The duration of treatment was gradually shortened, and the last 7 cases were given the drug for only 24 hrs; these received a total of about 6 gm during this period. Their responses with this short regime were as satisfactory as with the longer periods of therapy.

Determinations of the amounts of drug present in the bloods of the treated patients have not yet been made. It is of interest that Chloromycetin can be employed successfully without dependence upon the results of such assay techniques. The practicality of the use of Chloromycetin is further emphasized by the fact that 12 of the 25 patients were treated in estate hospitals, where conditions are no more favorable for complete nursing care than in the average private home in the United States.

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Effect of Cations Upon Recovery of the Guinea Pig Gut From Inhibition by Antihistaminics

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When the guinea pig ileum suspended in Tyrode is exposed to the action of antihistamine substances (Pyribenzamine, Neo-antergan, Antistin, Benadryl, etc.) for exactly 1 min and tested with a standard dose of histamine, every 1.5 min, after washing out the inhibitor, the course of recovery can be followed quantitatively. In a separate paper (*4*) we have defined the index R_{50} as the time in seconds necessary for a 50% recovery to be attained. Assuming that the response of the muscle to a certain dose of histamine is a measure of the number of receptors available (*2*, *3*), one can calculate the constant k, of a first-order reaction in the assumption that breaking up of the inhibitor-receptor complex follows the law of a monomolecular reaction. When this is done, we can verify that k increases continuously as recovery proceeds and that it follows the same law of increment as the percentage of response (P) during recovery. If k is plotted against P, a straight line is obtained, indicating that the newly formed receptors "catalyze" or otherwise influence formation or regeneration of the receptors. A plausible explanation for this fact would be that inhibition produced by the mentioned agents depends upon destruction of a metabolite, the presence of which is necessary for the normal interaction between active drug and the specific receptors. Regeneration of receptors would depend upon the autocatalytic reconstruction of the affected metabolite. An alternative explanation was suggested by the study of ions upon this phenomenon of recovery, as we see in continuation.

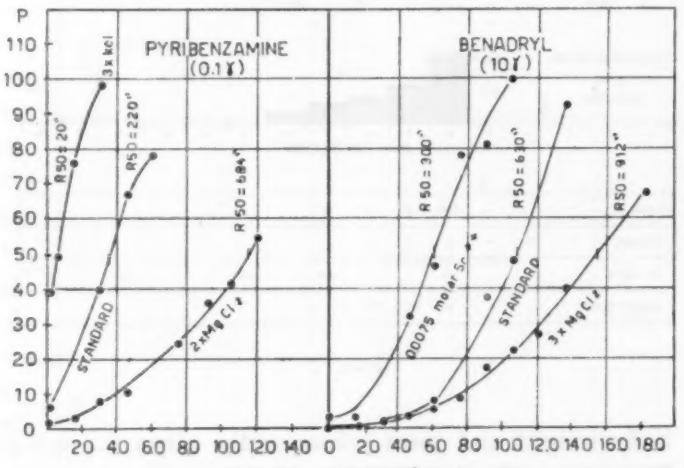

FIG. 1. Effect of increasing the concentrations of $MgCl_2$ and KCl of the standard Tyrode solution, as well as of adding 0.0075 molar of $SrCl_2$, upon recovery from inhibition of a piece of guinea pig ileum by Pyribenzamine and Benadryl. Ordinate: percentages of response to 0.2 cc of histamine, 1 : 2 millions.

Since recovery from inhibition produced by high doses of acetylcholine and histamine follows the same law as for other inhibitors, the work of Cantoni and Eastman (*1*) on the effect of KCl in suppressing refractoriness after high doses of histamine and acetylcholine acquired a timely interest. We decided, therefore, to study the effect of cations upon recovery of the gut from inhibition by Neo-antergan, Pyribenzamine, Benadryl, Antistin, Trasentin, etc. In all cases, 2–5 times the concentration of K^+ of the standard Tyrode solution produced a considerable accelerating effect. Mg^{++}, on the contrary, had a strong slowing-down effect when added in concentrations up to 2 or 3 times that of the Tyrode solution. Ca^{++} had a lesser effect than Mg^{++}, and, in some cases, it even had a slight accelerating effect, but in general its depressing effect was predominant. Surprisingly enough, Sr^{++}, even when present in the low concentration of 0.0025 molar, had a definite accelerating effect. Fig. 1 shows typical experiments with Pyribenzamine and Benadryl.

The accelerating effect of potassium and, in minor scale, of strontium must be understood as a somewhat specific effect and does not appear to depend upon equilibrium with calcium or magnesium. If 3 times Mg^{++} is combined with 3 times K^+, the accelerating effect of K^+ predominates; on the other hand, when the concentration of Ca^{++} is lowered to ½ of the standard, there occurs a slowing down of recovery, of the same extent as can be seen when K^+ is lowered to half of the standard. Sometimes, when calcium or potassium is lowered to half of the standard, complete recovery becomes impossible, but full activity can be rapidly restored by switching to a high potassium Tyrode. Absence of Mg^{++} in the perfusing Tyrode had slight or no effect upon the rate of recovery.

The effects of K^+, Ca^{++}, and Mg^{++} were similar but quantitatively different when assayed upon recovery from inhibition produced by high doses of acetylcholine and histamine. K^+ had the same strong effect, and therefore we could confirm Cantoni and Eastman (*1*). Ca^{++} had a stronger dilatory effect than that referred to above, although Mg^{++} was considerably less effective upon this kind of inhibition than toward inhibition produced by antihistaminics. Sr^{++}, which was so clearly accelerating upon recovery from inhibition by antihistaminics, had a moderate but definite depressant effect upon recovery from high doses of acetylcholine and histamine. This discrepancy is not well understood up to now and is being investigated.

From these studies it appeared likely that integrity of specific receptors depends upon a sort of polarization of the ionic layers supposedly present at the muscle surface and that inhibition or inactivation of receptors might depend upon disturbance of these ionic arrangements, the importance of which for muscle activity is well known. It has been shown, for instance, that myosin strongly adsorbs positive ions, the bivalent cations being adsorbed first. A third layer of ATP would establish conditions for muscle activity (*5*). Phenomena of autocatalytic interchange of these ionic layers has also been mentioned by Szent-Györgyi, although no single scheme might fit exactly with the phenomena here described.

The practical implications of these findings are obvious, since high concentrations of K^+ might contribute to decrease the effects of antihistaminics; on the other hand, a combination of Mg^{++} and Ca^{++} might contribute to strengthen the effect of these important therapeutic agents.

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Stubble Mulch Studies: Effect of Sweetclover Extract on Corn Germination

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Numerous studies have shown the varied influence of plant and microbial extracts and decomposition products on the growth of plants and microorganisms (*1–5*). In the rapidly expanding system of stubble mulch farming, plant materials are being used for mulching the soil to protect it against excessive runoff and erosion by wind and water. Under certain conditions, some mulching materials have been observed to reduce the stand and growth of corn. In the field, sweetclover has not been observed to influence stands of corn adversely. In fact, corn following sweetclover has been much more productive than that on land without legumes. This improved or stimulated growth usually has been attributed to the increased amount of available nitrogen released upon the decomposition of sweetclover residues.

The effect on germination of water extracts of several different plant materials including sweetclover was tested. Sweetclover hay that had been cut when the plants were about 18″–24″ high was used in the tests herein reported. Portions of the hay were cut into short lengths and placed in flasks with varying proportions of water. The corn seeds were then placed in the flasks and soaked in the sweetclover-water mixture for 24 hrs. At the end of the soaking period 5 seeds from each concentration of sweetclover extract were placed on an agar medium[1] in Petri dishes in quadruplicate. The plates were incubated at room temperature. After 3 days the root and top growth of the corn seedlings were measured and compared with those of seeds soaked in distilled water. The sweetclover had a more depressing effect on germination and seedling growth than did alfalfa, wheat straw, or oat straw. At times wheat straw in the laboratory has given no effect, and in other tests a stimulation of growth. The results with sweetclover are shown in Table 1. Even at a dilution of 1 part of sweetclover to 100 parts of water the growth of the corn seedlings was reduced.

[1] The medium (Crone's) contained all essential mineral nutrients except nitrogen, and 1.5% agar.

TABLE 1

INFLUENCE ON GERMINATION AND GROWTH OF SOAKING CORN SEEDS FOR 24 HRS WITH SWEETCLOVER EXTRACT

	Parts of plant material to distilled water	Germination (%)	Seedling growth after 3 days (length in cm)*	
			Tops	Roots
Sweetclover	1– 5	33	0.3	0.8
"	1– 10	52	0.5	0.9
"	1– 20	75	0.7	1.7
"	1– 80	92	1.8	3.8
"	1–100	87	1.6	4.0
Control		95	2.8	6.4

* Based on the number of germinated seeds.

The results with corn seeds soaked in different concentrations of coumarin in distilled water are shown in Table 2. It appears from these results that the coumarin in sweetclover may be one of the constituents of sweetclover that inhibited germination and growth of the corn seedlings.

TABLE 2

THE INFLUENCE ON GERMINATION AND GROWTH OF SOAKING CORN SEEDS IN COUMARIN SOLUTION FOR 24 HRS

Grams of coumarin in 100 ml of water	Germination (%)	Seedling growth after 3 days (length in cm)	
		Tops	Roots
0.125	0	0	0
0.062	0	0	0
0.031	12	0.3	0.4
0.015	42	0.4	0.5
0.007	90	1.2	4.2
None	95	2.9	7.6

From these and other results obtained in similar tests it appears that many plant residues contain substances which, under certain conditions, retard or inhibit germination and growth of plants in the seedling stage. This fact may have far-reaching implications with respect to the whole question of plant growth. However, the effect of these substances when in the soil and exposed to innumerable microbiological reactions may be entirely different than when in relatively pure cultures.

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IN THE LABORATORY

Dialysis of Protein Solutions for Electrophoresis

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Blood serum and other biological systems containing proteins as well as low-molecular, diffusible ions and organic compounds must be equilibrated against a suitable buffer mixture prior to study in the electrophoresis apparatus. By establishing Donnan equilibrium between the colloid and the supernatant solution, boundary anomalies due to pH and conductivity differences are eliminated to a certain extent (cf. *4*). At present it is standard procedure to dialyze the protein solution, after diluting it with buffer, against a large volume of the same buffer through Cellophane tubing at low temperature and for a considerable period of time. Thus, Longsworth, *et al.* (*3*), in their electrophoresis experiments on normal and pathological human blood serum and plasma, employed static dialysis at 0°–2° C for 3 days, changing the outside buffer solution every day. As an alternative procedure, these workers rotated the buffer solution for 1 hr at room temperature, replaced it by fresh buffer, and allowed dialysis to proceed for 24 hrs or more at 0°–2° C.

In clinical work, the time required for the equilibration process represents a factor of major importance since it delays appreciably the examination of the serum or plasma in the electrophoresis apparatus and hence the availability of the results to the medical staff. At the suggestion of Kurt G. Stern and with his help we have studied the time course of dialysis with a view of reducing it to a minimum compatible with the requirements of precise electrophoresis experiments. Various forms of mechanical dialyzers were built by the American Instrument Company, Silver Spring, Maryland, through the active cooperation of Gerald H. Lovins and Alfred Henley, of the Company's Research Department, and tested for performance under routine conditions in our laboratory. The construction of the dialyzer adopted for use as a result of this experimentation is shown in Fig. 1. For details of the design and components, reference is made to the figure. The Cellophane tubing employed in the experiments was seamless Visking sausage casing (Batch No. 295) placed at our disposal through the courtesy of the Visking Corporation, Chicago.

For the experiments reported here we used pooled human serum samples and sodium barbiturate buffer of 0.1 ionic strength and pH 8.5, as recommended by Longsworth (*2*) for electrophoretic experiments on human serum. For dialysis, one part of serum was diluted with two parts of barbiturate buffer. It was then placed in the Cellophane tubing and equilibrated with mechanical stirring against 25 volumina of the same buffer under the conditions to be described. In order to follow the process quantitatively, it was interrupted at frequent intervals, and aliquots of the protein solution were withdrawn from the dialysis bag into a Shedlovsky conductivity cell (of the type shown in *3*, p. 403), which was immersed in an ice-water mixture contained in a Dewar vessel. As soon as temperature equilibrium of the sample had been reached, the conductance was measured with the aid of an electronic conductivity bridge of the design of Frederick Kavanagh, kindly placed at our disposal by the Klett Manufacturing Company. This instrument consists of an R–C oscillator, giving signals of 1,000 as well as 2,200 cycles/sec frequency, a three-stage resistance-capacitance coupled amplifier, and the bridge proper incorporating a series of General Radio decade resistors of high precision. As indicators of balance between the unknown electrolytic resistance and the decade resistors, a 6E5 "magic eye" tube as well as a headphone is employed. The latter will detect an imbalance as small as about 0.002%, while the sensitivity of the "magic eye" indicator amounts to only 0.1% of imbalance. Before measurements, the bridge was checked against a cali-

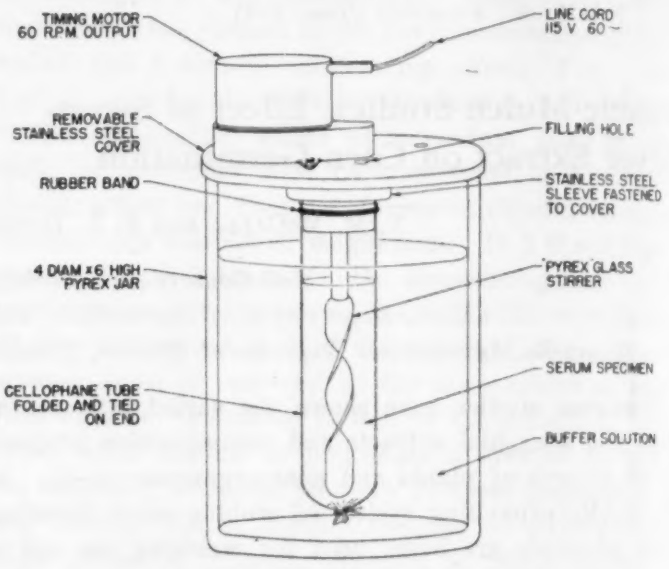

FIG. 1. Mechanical dialyzer (longitudinal section), showing Cramer synchronous motor, 115 v, 60 cycles AC, 60 r.p.m.; gear box of motor; stainless-steel cover with two holes; metal sleeve for dialysis bag, welded to cover; glass stirrer, made of 5/16" rod, 5" long; coupling of stirrer to motor axle, made of plastic tubing; protein solution, 30-ml volume; dialysis bag, made of Cellophane tubing, approximately 5" long and 1 1/8" in diameter, tied at bottom, and attached to sleeve by rubber band; outside buffer solution, approximately 770-ml volume; and Pyrex glass jar, 4" wide and 6" high (Corning No. 850).

brated General Radio precision resistor of 10,000 ohms. The conductivity cell had a cell constant of C = 6.69, as determined by calibration with 0.1 N KCl solution. Each time when dialysis was interrupted by removal of the Cellophane bag from the dialyzer, a 5-ml aliquot was removed from the outside buffer solution for subsequent conductance measurements. Upon completion of the measurement of the protein sample, it was returned to the solution in the bag and dialysis was promptly resumed. In this manner, appreciable volume changes of the serum samples during the course of the experiment were avoided. While conductance measurements were mainly relied upon for determining the rate of equilibration of the serum against the buffer, pH-measure-

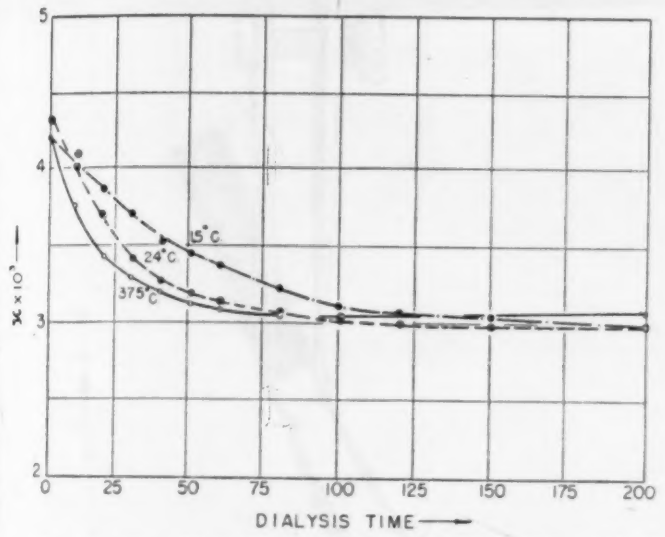

FIG. 2. Equilibration of human blood serum against barbiturate buffer through Cellophane at three different temperatures, with mechanical stirring.

ments were also performed on the inside and outside solutions before and after the experiment as additional checks.

In order to study the temperature dependence of the equilibration process, dialysis experiments were conducted at 1.5, 24, and 37.5° C by immersing the entire dialyzer into water baths of the appropriate temperature and allowing the outside buffer solution to attain the temperature of the bath before starting the experiment. While the conductance of the buffer solution changed little throughout the experiment, that of the diluted serum decreased and approached a value slightly below that of the buffer solution at a rate which was a function of temperature. Changes in conductance of the serum samples throughout the course of dialysis for the three temperatures mentioned above is shown graphically in Fig. 2. It is evident that the initial slope of the conductance curves increases with increasing temperature. While equilibration at 37.5° C is practically complete after 60 min of dialysis, 100 min are required at 24° C and 150 min at 1.5° C. For practical purposes, room temperature appears to be preferable to either 1.5° or 37.5°, since the rate of equilibration at 20°–24° C is sufficiently rapid to allow for the dialysis of 6 serum samples in three dialyzers per 8-hr working day without involving the risk of secondary changes which might conceivably occur during dialysis at 37° C.

The pH and specific-conductance values of the diluted serum and buffer solutions before and after equilibration are shown in Table 1. The small but consistent differences in the final conductance values are due to the Donnan effect caused by the presence of nondiffusible colloid ions, viz. the serum proteins (cf. *1*).

TABLE 1

EQUILIBRATION OF HUMAN SERUM AGAINST BARBITURATE BUFFER BY DIALYSIS THROUGH CELLOPHANE WITH MECHANICAL STIRRING

	Human serum (3 times diluted)		Barbiturate buffer ($\mu = 0.1$)	
Dialysis	Initial	Final	Initial	Final*
Temperature	pH $\kappa \times 10^3$	pH $\kappa \times 10^3$	pH $\kappa \times 10^3$	pH $\kappa \times 10^3$
1.5° C	... 4.20	8.54 2.98	8.55 3.08	8.55 3.14
24° C	8.62 4.31	8.60 3.00	8.58 3.09	8.59 3.15
37.5° C	8.49 4.23	8.51 3.09	8.53 3.08	8.52 3.21

* All final values were determined after 200 min of dialysis, all conductivities were measured at 0° C, and pH values were determined with a Cambridge pH-Meter at room temperature.

Next, the effect of mechanical stirring on the rate of equilibration was determined by performing two experiments at 24° C, in one of which the stirrer was kept stationary. The results (see Fig. 3) showed clearly the

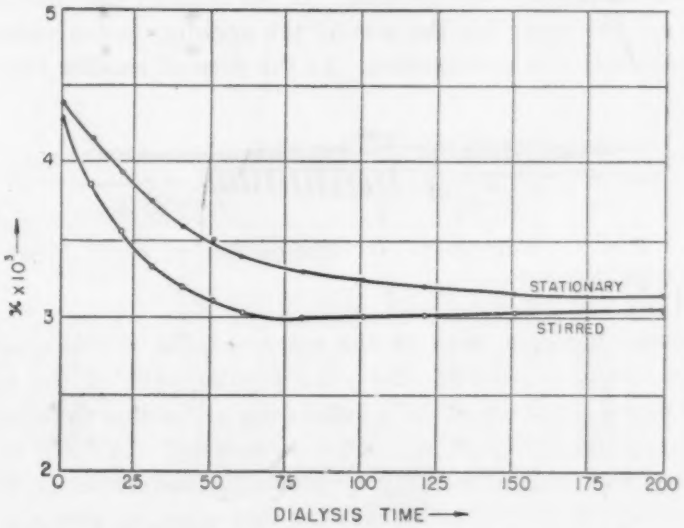

FIG. 3. Effect of mechanical stirring on rate of equilibration of serum against barbiturate buffer at 24° C.

increase in equilibration rate with mechanical stirring: while in the latter case equilibrium was reached after approximately 60 min of dialysis, equilibrium was incomplete even after 200 min without stirring.

For the sake of economy, changes of the outside buffer solution were omitted; this is permissible in the instance of blood serum, the chief inorganic components of which are sodium chloride and sodium bicarbonate. When ammonium sulfate or sodium sulfate containing protein fractions are dialyzed prior to electrophoretic examination, the outside buffer solution should be renewed before electrophoresis because of the considerable increase in conductance caused by the neutral salt.

The experiments described show that it is possible to equilibrate protein solutions against a buffer within 2 hrs, using Cellophane tubing and a simple mechanical dialyzer. This reduces considerably the time required for electrophoretic examination of clinical material, e.g. blood serum.

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A Simple Aid for the Cannulation of Small Blood Vessels

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Cannulation of the larger blood vessels (1 mm or more in diameter) offers no special difficulty. The most common method is to pick up a small portion of the wall of a vessel with tissue forceps, snip part way through the wall (about one-third of the circumference), lift up the triangular flap with the tissue forceps, and insert the cannula through the opening. If the head of the cannula is not too large for the size of the opening in the vessel, no difficulty is encountered. In the case of smaller blood

FIG. 1. Forceps to aid cannulation of small blood vessels.

vessels, however, such as the artery of the rabbit's ear, the caudal or carotid artery or jugular vein of the rat or mouse, or the aorta of a small frog or toad, cannulation may prove difficult and time consuming. Making the usual cut in the wall of a very small blood vessel is difficult, even with small sharp-pointed scissors, and when this is accomplished, the cut vessel is frequently torn across during manipulation for the insertion of the cannula. For this reason, either a sharp metal needle or sharp-pointed small glass cannula of appropriate size has usually been inserted into the lumen by direct puncture of the wall of the vessel. This has the obvious disadvantage of leaving in the vessel a sharp point which frequently punctures the wall at some other site, if the animal moves or if the cannula is manipulated. For these reasons it is considered of interest to report on the development of a simple contrivance (Fig. 1) which enables the rapid insertion of a blunt glass, metal, or plastic cannula into a small blood vessel.

The lower portions of the two blades of a small tissue forceps are bent at a right angle and sharpened into two thin, short, (about 3 mm) sharp-pointed prongs with flat inner surfaces which can be brought into perfect contact by pressure on the handles. The distance which the blades of the forceps are permitted to separate is first adjusted with the set screw, as shown in Fig. 2. A slight pressure exerted on the handles approximates the prongs of the blades to form a thin, sharp needle with which the wall of the vessel is pierced. Upon release of the pressure on the handles the prongs separate to the predetermined distance, creating an opening through which the head of the cannula can be introduced. The

FIG. 2. Position of forceps during insertion of cannula into blood vessel (×5).

prongs also act as guides for the insertion of the head of the cannula. With the blood vessel held in position, a slight upward pull of the forceps results in an enlarged opening which further facilitates insertion of the cannula. The blades of the forceps are then withdrawn from the vessel, leaving the head and neck of the cannula in place, to be tied in in the usual fashion. Precaution to keep the vessel moist is observed throughout the course of these manipulations. If the head of the cannula is not too large for the opening in the wall and for the lumen of the vessel, the insertion is accomplished easily and expeditiously.

In experiments in which it was frequently necessary to cannulate small arteries and veins as small as 0.3 mm in diameter, this instrument proved of great help. The device can also be used for the cannulation of large vessels, because it facilitates the insertion of a cannula with a head of even larger diameter than that of the natural, undistended lumen of the vessel, and because this is accomplished with a minimum of injury to the wall of the vessel.